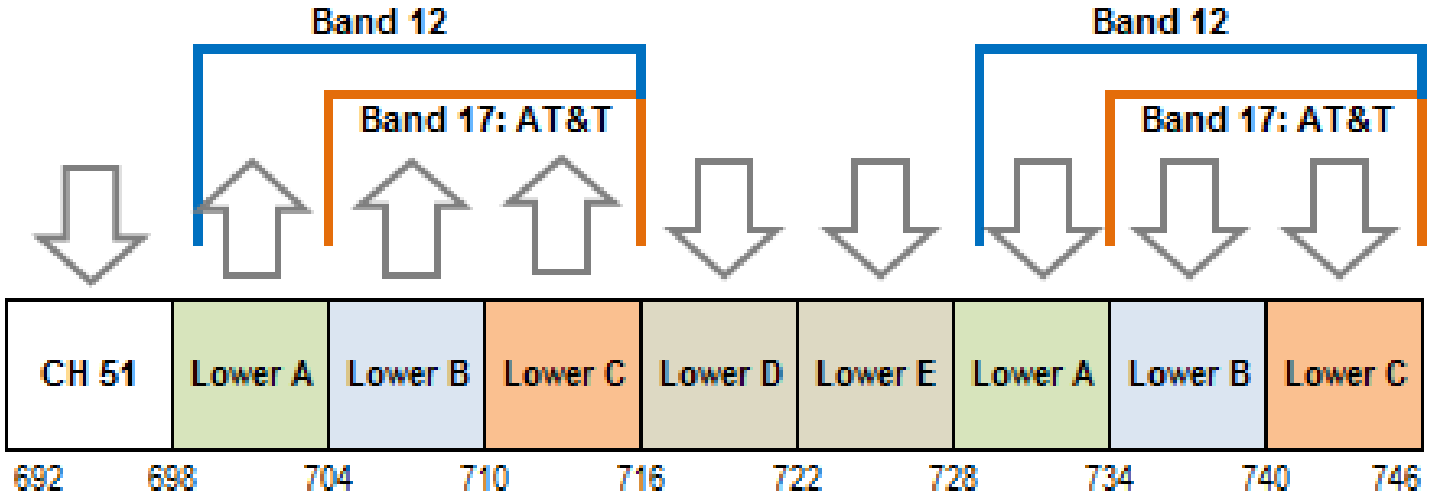
Lower 700 MHz Interoperability

August 1, 2012

NPRM for 700 MHz Interoperability

- WT Docket No. 12-69 was established to:
  - "Evaluate whether the *customers of Lower 700 MHz B and C Block licensees would experience harmful interference* - and if so, to what degree - if the Lower 700 MHz band were interoperable." (NPRM at 5)
- The scope is focused on devices:
  - "We focus the scope of this proceeding to interference to Lower 700 MHz B and C Block operations that may *result from the adoption of Band Class 12 devices* by Lower 700 MHz B and C licensees, whether voluntarily or by regulatory mandate." (NPRM at 32)
- The NPRM requested evidence of interference:
  - "We ask interested parties *to submit measurements and quantitative analyses* regarding the *magnitude and extent of the interference risk* from adjacent Channel 51 and Lower Block E transmissions for Band Class 12 devices operating in the Lower B and C Blocks." (NPRM at 40)



Band 12 Measurements Prove: No Interference

- Channel 51 signals do not cause harmful interference to Band 12 devices.
  - The Hyslop-Kolodzy report measured Band 17 device performance and analytically determined Band 12 performance.
  - The V-COMM report measured Band 12 and Band 17 devices, confirming the HK results.
  - Both reports demonstrated that a Channel 51 signal would need to be unusually strong, greater than -13 dBm, to begin affecting Band 12 devices in the weakest LTE coverage.
  - Hyslop-Kolodzy and V-COMM measured Channel 51 signal strength in Atlanta, Chicago, New Jersey, and Iowa, demonstrating that such strong Channel 51 signals rarely occurred.
- Lower E Block signals do not cause harmful interference to Band 12 devices.
  - Hyslop-Kolodzy measured commercial Band 17 devices in the laboratory and verified 73 to 74 dB receiver selectivity for the second-adjacent channel, which is sufficient to prevent interference from E Block transmissions.
  - V-COMM laboratory tests of Band 12 and Band 17 devices also demonstrated receiver selectivity of 74 dB or greater with respect to the E Block.
  - The Hyslop-Kolodzy report provided field measurements of Dish Lower E Block towers in Atlanta, verifying that commercial Band 12 devices would not experience interference from the 50 kW Lower E Block transmissions.

Band 17 Proponents Provided Flawed Data

- Qualcomm did not test 700 MHz components or devices.
  - Qualcomm asserted that commercial device performance closely follows 3GPP specifications, but provided no evidence to support such a claim.
  - Qualcomm's sole measurement was of a 1900 MHz power amplifier in a configuration that does not reflect the channels in the Lower 700 MHz Band.
  - Qualcomm did not disclose the assumptions and performance criteria underlying their interference claims. Due to the absence of this information it is impossible to verify such claims.
  - Qualcomm's D Block coverage plots did not exhibit signal levels that would cause commercial Band 12 device receiver blocking in MediaFLO markets.
- The AT&T-commissioned tests of Channel 51 intermodulation are flawed.
  - The test reports provided by 7layers and PCTest indicate that they did not sufficiently filter the signal generator emissions.
    - Signal generators produce emissions outside of their transmission bandwidth. In device receiver tests, these emissions may cause interference apart from the conditions under test.
    - Both test results are invalid due to the presence of this in-band noise in the receive channel.
  - Further, both tests placed the LTE channel at the upper end of the B+C Blocks.
    - Such an LTE channel placement within the 12 MHz block increases the IM frequency overlap with the receive channel and therefore reduces the DTV signal level at which interference begins to occur.
    - This LTE channel placement does not reflect AT&T's commercially deployed systems and is not representative of the experience of Lower B and C Block customers. Such a placement would also increase interference to AT&T's Lower B and C Block base stations from AT&T's D Block downlink transmissions.

Neither company tested E Block interference.

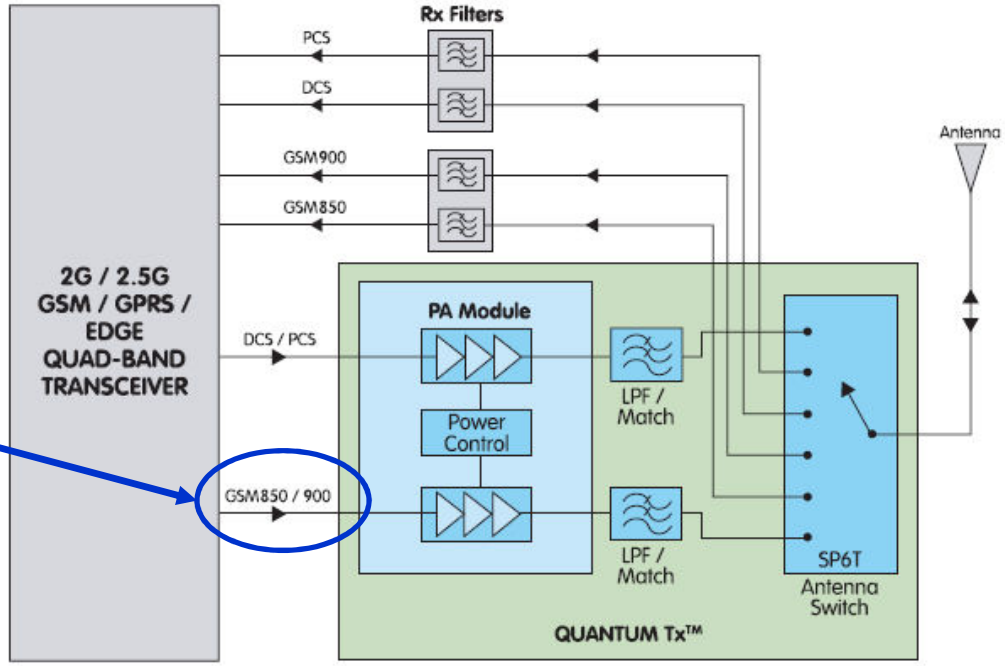
Band 17 Proponents' Interoperability Concerns May Be Readily Solved

- Pre-2012, Band 17 proponents were concerned that interference might require separate Band 12 and Band 17 hardware, posing an equipment barrier to interoperability.
- The Hyslop-Kolodzy and V-COMM test reports have proven that interference would not result for Band 12 devices, enabling the same hardware to be used for all Lower A, B and C Block LTE devices.
- In their June 1, 2012 comments, AT&T stated that interoperability could be achieved with the multiple Frequency Band Indicator feature being standardized by 3GPP, which would enable support of both legacy Band 17 devices and new Band 12 devices on the same network. AT&T expressed concern that the timing of this feature may be insufficient to provide a rapid achievement of interoperability. (AT&T Comments, Declaration of David R. Wolter, p. 7).
- Other solutions may provide interoperability in the interim until this 3GPP feature is commercially available. For instance, since the device only requires one set of hardware for the entire Lower 700 MHz Band, the chipset software could support Band 12 and Band 17 within the same hardware, selecting the applicable network depending on the coverage area.

Interoperability Solution Example: Chipset Software Approach

- Device chipsets today support two bands on a single chipset port when the RF components for the bands are similar:

Two low frequency bands (850 MHz and 900 MHz) share chipset ports



Source: Triquint Brochure

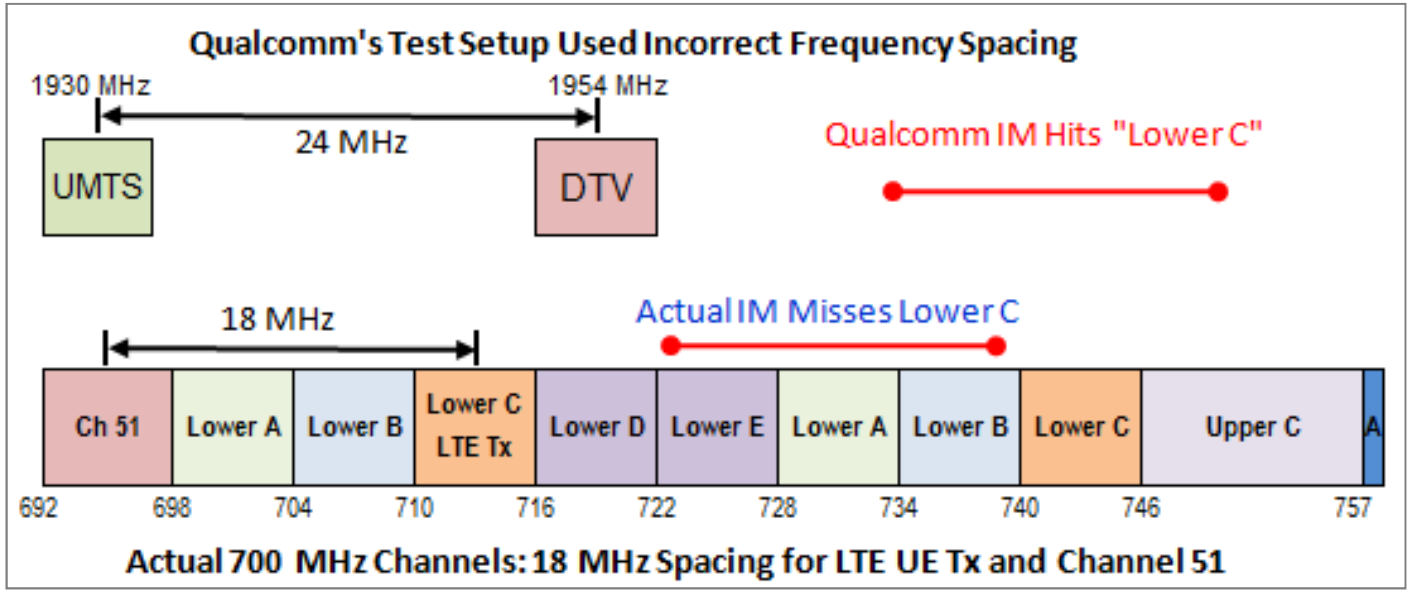
- In the interim until multiple FBI is available, new Lower 700 MHz devices could support both Bands 12 and 17 using the same device hardware.
- The device software would select either Band 17 or Band 12 depending on the operator preference and roaming situation.
- This solution would not impact legacy devices or infrastructure, and would not impact the size or cost of new devices.

BACKUP

Qualcomm Test Setup

Qualcomm's test configuration was not applicable to the Lower 700 MHz Band.

- Qualcomm tested a Band 1 UMTS power amplifier with a transmit frequency of 1930 MHz.
- The DTV interferer was centered at 1954 MHz, 24 MHz away from the UMTS power amplifier frequency.
- Qualcomm's frequency spacing did not represent the configuration of Channel 51 and 700 MHz. It is akin to D Block and Channel 51 mixing to create IM, which is not the situation under discussion.



Qualcomm's Tests

- The use of the wrong frequency separation may have led Qualcomm to draw incorrect conclusions about where intermodulation products would fall in a 700 MHz LTE situation.
  - For instance, Qualcomm incorrectly claimed that a Lower C Block UE transmission could cause IM interference to Lower C Block receive frequencies, based on the larger frequency gap in their 1900 MHz configuration.
- Qualcomm used a 3GPP Band 1 power amplifier with potentially inferior linearity relative to 700 MHz components. This difference would make the test results inapplicable to Lower 700 MHz performance.
- Qualcomm's comments did not include the intermodulation measurement data or test setup details. Without the actual measurements and test configuration, it is not possible to validate the test results.
- Qualcomm did not explain how they translated the 1930 MHz power amplifier tests into 700 MHz receiver impacts.
  - Qualcomm may have used theoretical analysis to generate their subsequent figures, but did not explain the assumptions used in the analysis.
  - Without documentation of these assumptions and performance criteria, it is not possible to validate their conclusions.

Qualcomm's tests of reverse PA IM do not appear to be applicable to the Lower 700 MHz Band.

AT&T's Tests

- AT&T's tests did not include sufficient filtering of the test equipment noise:

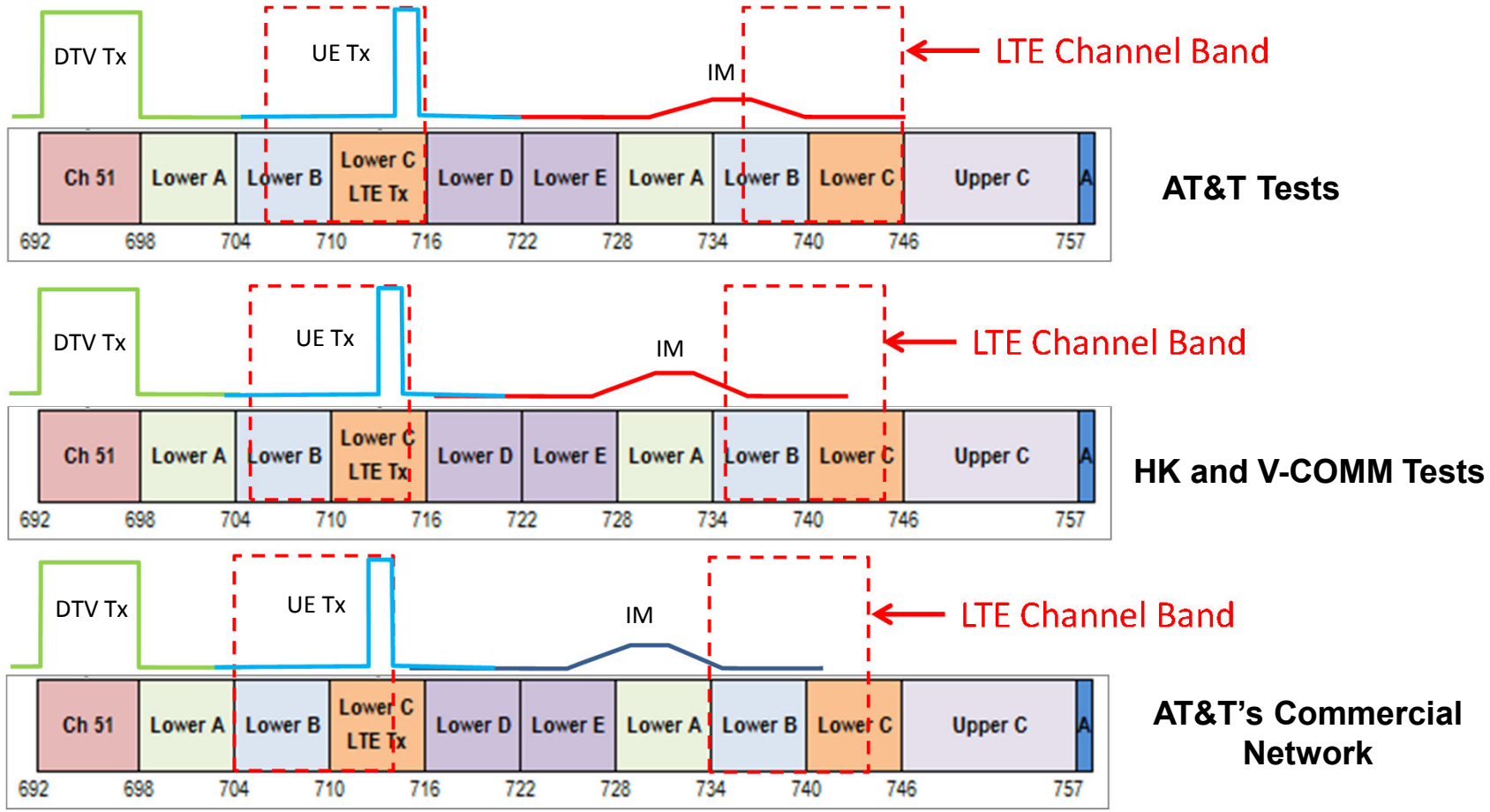
  "The Channel 51 broadcast emulator above must be capable of attenuating wideband noise in the 734-746 MHz range to a power of less than -90 dBm/10 MHz (-160 dBm/Hz) when generating a -20 dBm/6 MHz downlink signal." (AT&T reply comments, AT&T Test Plan, p. 3).

- This noise level interfered with the desired LTE signal level:
  - Equipment noise for Ch 51 transmission at -20 dBm: -160 dBm/Hz is equal to -90.5 dBm/9 MHz
  - Equipment noise for Ch 51 transmission at -30 dBm: -100.5 dBm/9 MHz
  - Downlink LTE signal for Band 12 (PCTest): -97.8 dBm/9 MHz
  - The critical range in AT&T's tests was -20 to -30 dBm. Within this range, the test generator noise was close to or greater than the LTE downlink signal, causing errors unrelated to reverse PA IM.
- Both tests followed the same approach.

AT&T's Channel 51 test results are invalid.

AT&T's Tests Did Not Reflect Deployment Reality

- Three cases of LTE channel placement within the Lower B and C Blocks (12 MHz):
  - AT&T Tests: Placed the LTE Channel far to the right, with a worst case IM overlap with Lower B.
  - HK and VCOMM Tests: Placed LTE Channel in the center of B&C Block, more pessimistic than the deployed system.
  - AT&T Commercial System: Places LTE Channel far to the left to limit interference problems with Lower D Block.



AT&T's Commercial Network channel provides the least IM overlap with the Lower B Block, resulting in much better performance than the AT&T, Hyslop-Kolodzy, or V-COMM tests.